

## 1 PERICARDIAL RETRACTOR

2  
3 BACKGROUND OF THE INVENTION  
4

## 5 1. Field of the Invention

6 The invention relates to minimally invasive surgery. More  
7 particularly, the invention relates to a pericardial retractor for  
8 use in endoscopic heart surgery.

9  
10 2. State of the Art

11 When performing surgery it is sometimes necessary to open and  
12 retract soft tissues that envelop or block access to the organs or  
13 structures to be operated on. For example, in endoscopic heart  
14 surgery it is necessary to suspend the pericardium in order to  
15 access the heart. However, tissue retraction is difficult in  
16 minimally invasive or endoscopic surgery because of the limits of  
17 space and the small number of entry sites.

18  
19 Several devices exist for the retraction of tissue during  
20 endoscopic and laparoscopic surgery. These devices are designed  
21 to be delivered into the body through a small incision or through  
22 an introduction tube which passes through a small incision.  
23 Typically, the retraction devices include a deployable member  
24 which is attached to a string or cable. After the device is

1 deployed on the distal side of soft tissue, the string is pulled  
2 out of the body, thereby lifting the tissue. (As used herein, the  
3 term "distal" means farther from the practitioner and the term  
4 "proximal" means closer to the practitioner.) When the tissue is  
5 sufficiently retracted, the device is held in place by clamping  
6 the string with a hemostat or other type of clamp.

7

8 U.S. Patent Number 5,613,939 to Failla discloses several  
9 complex deployable devices. Some of them are difficult to deploy  
10 and most of them are difficult to remove when surgery is complete.

11

#### 12 SUMMARY OF THE INVENTION

13

14 It is therefore an object of the invention to provide a  
15 surgical retractor.

16

17 It is also an object of the invention to provide a surgical  
18 retractor which is suitable for use in endoscopic surgery.

19

20 It is another object of the invention to provide an  
21 endoscopic surgical retractor which is suitable for lifting the  
22 pericardium during endoscopic heart surgery.

23

1       It is still another object of the invention to provide an  
2   endoscopic surgical retractor which is simple in its construction  
3   and its use.

4  
5       It is yet another object of the invention to provide an  
6   endoscopic surgical retractor which is easily deployed and equally  
7   easy to remove from the body when surgery is complete.

8  
9       In accord with these objects which will be discussed in  
10   detail below, the surgical retractor of the present invention  
11   includes a "swivel" having a string extending from one end and a  
12   string extending from the midpoint between the two ends. As used  
13   herein, the term "string" is meant to include any suitable string-  
14   like member, e.g. a cable, filament, suture, etc. Moreover, the  
15   two strings may actually be a single length of string which is  
16   looped through the swivel or which has opposite ends attached to  
17   the swivel. The swivel is delivered by pushing it out of a tube  
18   which, when used in endoscopic heart surgery, is inserted through  
19   a small incision between the ribs of the patient. When the swivel  
20   member is deployed, the tube is removed and the string which is  
21   attached to the center of the swivel is pulled to lift the  
22   pericardium. When the procedure is complete, the swivel is  
23   removed from the patient by pulling the string attached to the end  
24   of the swivel.

1       According to one embodiment, the swivel is a cylinder with a  
2 blunt conical end and an opposite keyed end. The keyed second end  
3 is engaged by the distal end of a pushrod which is movable through  
4 a delivery tube. The tube and/or pushrod may be hereinafter  
5 referred to as a "deployment tool". The proximal end of the  
6 delivery tube is coupled to a housing and the proximal end of the  
7 push rod is coupled to a push button in the housing. The push  
8 button has a locking ring which locks the pushrod in the deployed  
9 position when the push button is pushed. The strings attached to  
10 the swivel pass through the hollow pushrod and out of the housing.  
11 The strings are preferably different colors so that they can be  
12 distinguished one from the other. Alternatively, the strings may  
13 be labeled.

14  
15       According to a second embodiment of the invention, the swivel  
16 has a sharp end which is covered by a spring loaded collar (safety  
17 shield). The swivel is coaxially mounted on the distal end of the  
18 delivery tube. The sharp end of the swivel is used to puncture  
19 the patient's chest and pericardium in order to introduce the  
20 device. Once introduced, the spring loaded collar slides over the  
21 sharp point so that it does not damage any tissues. A pushrod  
22 inside the delivery tube is used to deploy the swivel.

23

1 Additional objects and advantages of the invention will  
2 become apparent to those skilled in the art upon reference to the  
3 detailed description taken in conjunction with the provided  
4 figures.

5

6 BRIEF DESCRIPTION OF THE DRAWINGS

7

8 Figure 1 is a perspective view of a first embodiment of a  
9 pericardial retractor according to the invention prior to  
10 insertion into the patient;

11

12 Figure 2 is a broken perspective view of the retractor at  
13 initial insertion through the chest but prior to piercing the  
14 pericardium wall;

15

16 Figure 3 is a perspective view of the retractor with the  
17 swivel partially deployed;

18

19 Figure 4 is a broken perspective view of the retractor after  
20 piercing the pericardium with the swivel partially deployed;

21

22 Figure 5 is a perspective view of the retractor with the  
23 swivel fully deployed;

24

1        Figure 6 is a broken perspective view of the retractor after  
2        piercing the pericardium with the swivel fully deployed;  
3

4        Figure 7 is a perspective view of the retractor with the  
5        swivel fully deployed and released to perform retraction;  
6

7        Figure 8 is a broken perspective view of the retractor after  
8        piercing the pericardium with the swivel fully deployed and  
9        performing retraction;  
10

11       Figure 9 is a broken side elevation view illustrating removal  
12       of the swivel after surgery;  
13

14       Figure 10 is a broken longitudinal sectional view of the  
15       handle portion of the retractor;  
16

17       Figure 11 is a broken perspective view of the distal end of  
18       the retractor with the swivel detached from the pushrod;  
19

20       Figure 12 is an exploded perspective view of the proximal  
21       handle portion of the retractor;  
22

23       Figure 13 is a broken perspective view of the distal portion  
24       of a second embodiment of the invention;

1        Figure 14 is a broken sectional view of the distal end of the  
2 retractor of the second embodiment;

3  
4        Figure 15 is a view similar top Figure 13 showing the swivel  
5 partially deployed;

6  
7        Figure 16 is a view similar to Figure 14 showing the swivel  
8 partially deployed;

9  
10       Figure 17 is a view similar top Figure 13 showing the swivel  
11 fully deployed;

12  
13       Figure 18 is a view similar to Figure 14 showing the swivel  
14 fully deployed;

15  
16       Figure 19 is a view similar top Figure 13 showing the swivel  
17 in position for removal from the surgical site;

18  
19       Figure 20 is a view similar to Figure 14 showing the swivel  
20 in position for removal from the surgical site; and

21  
22       Figure 21 is an exploded perspective view of the distal  
23 portion of the retractor.

## 1 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

2  
3 Referring now to Figures 1-12, a first embodiment of a  
4 surgical retractor 10 includes a hollow tube 12 having a proximal  
5 end 14 and a distal end 16. A hollow pushrod 18 extends through  
6 the hollow tube 12. The proximal end 14 of the tube 12 is coupled  
7 to a housing 20 which contains a push-button 22 which is coupled  
8 to the proximal end of the pushrod 18.

9  
10 A bullet shaped "swivel" 24 is removably mounted in the  
11 distal end 16 of the tube 12. Two strings 26, 28 extend from the  
12 swivel 24 through the hollow tube 12 (preferably through the  
13 hollow pushrod 18) and exit through one or more holes 30 in the  
14 push-button 22. As used herein, the term "string" can mean cable  
15 or suture or filament or wire or other similar structure.

16  
17 As seen best in Figures 9 and 11, one of the strings 26  
18 extends from substantially the midpoint along the length of the  
19 swivel 24 and the other string 28 extends from the proximal end of  
20 the swivel 24. According to this embodiment, the swivel 24 has a  
21 blunt conical end 24a, an axial bore 24b, a radial bore 24c, a  
22 shoulder 24d, a T-shaped keyway 24e, and a surface groove 24f  
23 which extends from the bore 24c to the proximal end of the swivel  
24 24. As seen best in Figure 11, the strings 26, 28 are knotted

1 together in the radial bore 24c. If the strings 26, 28 are a  
2 single length of string, a knot or similar structure is provided  
3 at 24c to prevent the string from detaching from the swivel.  
4

5 As seen best in Figure 11, the distal end of the pushrod 18  
6 is provided with a T-shaped key 18a. This key is adapted to  
7 engage the keyway 24e in the proximal end of the swivel 24 prior  
8 to deployment of the swivel. This coupling is suggested in  
9 Figures 4 and 6. When the pushrod and swivel are coupled in this  
10 way, the proximal end of the swivel 24 up to the shoulder 24d is  
11 received by the distal end of the tube 12.

12

13 Turning now to Figures 10 and 12, the housing 20 has two  
14 parts: a distal ferrule 20a and a proximal cover 20b. The distal  
15 ferrule 20a is force fit onto annular ridges 14a at the proximal  
16 end 14 of the hollow tube 12 and the cover 20b is force fit or  
17 sonically welded to the ferrule 20a. The proximal cover 20b  
18 includes an interior locking groove 20c and a proximal opening  
19 20d. The push-button 22 has a T-shaped profile with an annular  
20 groove 22a at the wider distal end and a central bore 22b which  
21 extends from the distal end to the string hole(s) 30. A locking  
22 ring 21 is placed in the annular groove 22a. The proximal end of  
23 the pushrod 18 is provided with an annular groove 18b which  
24 receives a thrust washer 23.

1       As seen best in Figure 10, the narrow proximal part of the  
2 push-button 22 extends out of the proximal opening 20d of the  
3 cover 20b and the locking ring 21 frictionally engages the  
4 interior wall of the cover 20b. The proximal end of the pushrod  
5 extends into the central bore 22b of the push-button 22 and is  
6 prevented from passing through the push-button by the thrust  
7 washer 23. From the foregoing, it will be appreciated that the  
8 push-button may be moved from the position shown in Figure 10  
9 downward until it reaches the top of the ferrule 20a which  
10 prevents further downward movement. When the push-button 22 is  
11 fully depressed, the locking ring 21 engages the locking groove  
12 20c and prevents the button from moving proximally.

13  
14       Turning now to Figures 1 and 2, the initial state of the  
15 retractor 10 has the push-button 22 in the proximalmost position  
16 with the swivel 24 coupled to the pushrod as previously described  
17 and the proximal end of the swivel embraced by (i.e. inside) the  
18 distal end 16 of the tube 12. It will be appreciated that in this  
19 state, the string 26 lies in the surface groove 24f of the swivel  
20 so that the string is not pressed between the swivel and the tube  
21 12.

22  
23       According to this embodiment, the conical tip 24a of the  
24 swivel 24 is not sharp enough to pierce the skin. Therefore, the

1 first step in using the retractor is to make a small incision in  
2 the chest wall 1 (Figure 2) between ribs 2. The retractor 10 is  
3 then inserted through the incision as shown in Figure 2. The  
4 conical tip 24a of the swivel is sharp enough to puncture the  
5 pericardium 3 as shown in Figure 4.

6  
7 After the pericardium is pierced, the push-button 22 is  
8 depressed as shown in Figures 3 and 4. This causes the pushrod 18  
9 to move distally out of the tube 12 causing the swivel to move out  
10 of the tube as well. At this point, the key 18a of the push-rod  
11 18 is still engaging the keyway 24e of the swivel 24. With the  
12 instrument configured in this manner, the string 26 which is  
13 attached to the middle of the swivel is pulled as shown in Figures  
14 5 and 6. Because the string 26 extends on the opposite side of  
15 the swivel 24 from the T-shaped key 18, this causes the swivel 24  
16 to "swivel" off the T-shaped key 18a at the distal end of the  
17 pushrod 18. When the string 26 has been pulled tight, the keyway  
18 24e of the swivel 24 is no longer coupled to the key 18a of the  
19 pushrod 18.

20  
21 Preferably, the tube 12 and pushrod 18 are then lifted out of  
22 the pericardium, away from the swivel 24 as shown in Figures 7 and  
23 8. When this is done the swivel 24 remains inside the pericardium  
24 3 as shown in Figure 8. Pulling on the string 26 will retract the

1 pericardium 3 because the swivel will remain substantially  
2 perpendicular to the string 26 and the axis of the incision in the  
3 pericardium 3. The pericardium may be held in the retracted  
4 position by clamping the string 26 with a hemostat or similar  
5 clamp.

6  
7       When surgery is complete or when it is no longer necessary to  
8 retract the pericardium, the string 26 is released and the string  
9 28 which is attached to the proximal end of the swivel 24 is  
10 pulled as shown in Figure 9. This allows the swivel to be removed  
11 from the pericardium 3 and the chest 1 because the swivel will  
12 assume a direction coaxial to the string 28 and to the axes of the  
13 incisions in the pericardium and chest wall.  
14

15       Particular features and advantages of the first embodiment  
16 include the following. The deployment, use and removal of the  
17 swivel is very simple and effective. The keyed connection between  
18 the pushrod and the swivel prevents the separation of the two  
19 until the push-button is pressed. It also prevents the axial  
20 rotation of the pushrod relative to the swivel or vice versa,  
21 which could cause the strings to become entangled. The locking  
22 feature of the push-button assures that the practitioner will  
23 always know whether the swivel has been deployed. Unlike some  
24 known endoscopic retractors, the retractor of the invention only

1 requires one entry site to deploy and remove. The point at the  
2 end of the swivel is sharp enough to pierce the pericardium (i.e.  
3 blunt dissection) but blunt enough to protect other tissues.

4  
5 As mentioned above, it is preferable that the two strings 26,  
6 28 be easily distinguishable from each other. This may be  
7 accomplished by color coding or by labeling.

8  
9 A second embodiment of the invention is illustrated with no  
10 proximal actuator in Figures 13-21. From the following  
11 description, those skilled in the art will appreciate how the  
12 second embodiment can be used with the same proximal actuator 20,  
13 22 shown in the previous Figures or used as shown.

14  
15 Referring now to Figures 13 and 14, the second embodiment 110  
16 includes a hollow tube 112 having a proximal end 114 and a distal  
17 end 116. A pushrod 118 extends through the tube 112. In this  
18 embodiment, the pushrod 118 is not hollow but has a pair of  
19 surface grooves 118a, 118b. A swivel 124 is removably mounted on  
20 the distal end 116 of the tube 112. A pair of strings 126, 128  
21 extend from the swivel 124 through the tube 112 along the grooves  
22 118a, 118b in the pushrod 118. As seen in Figure 14, the strings  
23 126, 128 are actually a single string looped around a centrally  
24 located pin 131 in the swivel 124.

1       The distal portion of the swivel 124 has a sharp distal end  
2 124a which is shaped like the point of a trocar (seen best in  
3 Figure 21) and a shoulder 124b. The proximal end of the swivel  
4 has a surface groove 124c and a throughbore 124d which extend  
5 substantially half way to the distal end. A safety shield 125  
6 having a distal shoulder 125a and a pair of longitudinal slots  
7 125b, 125c is mounted over the distal end of the swivel with a  
8 spring 127 biased between the shoulders 124b and 125a. A  
9 diametrical pin 129 extends through the swivel proximal of the  
10 shoulder 124b and engages the slots 125b, 125c. Those skilled in  
11 the art will appreciate that the distal end of the swivel  
12 resembles a trocar used to make incisions during endoscopic and  
13 laparoscopic surgery. The proximal portion of the swivel is  
14 dimensioned to fit partially into the distal end 116 of the tube  
15 112 and the distal portion is dimensioned to have approximately  
16 the same outer diameter as the tube 112. As seen best in Figure  
17 16, the distal end 118c of the pushrod 118 is rounded as is the  
18 proximal end 124e of the swivel 124 which abuts it.

19  
20       From the foregoing, those skilled in the art will appreciate  
21 how the second embodiment of the invention is used. Starting with  
22 the instrument configured as shown in Figures 13 and 14, the  
23 distal end of the safety shield 125 is pressed against the chest  
24 wall between two ribs. The pressure causes the safety shield 125

1 to be pushed back against the spring 127 exposing the sharp end  
2 124a of the swivel 124. Further pressure punctures the chest  
3 wall. When the shield 125 passes into the space between the chest  
4 wall and the pericardium, the spring 127 biases the shield 125  
5 back to the safety position shown in Figures 13 and 14. Advancing  
6 the instrument further pierces the pericardium. The function of  
7 the shield is to prevent accidental damage to other tissues and to  
8 prevent ripping of the pericardium when the swivel is retracted.

9  
10 After the pericardium is pierced, the pushrod 118 is advanced  
11 through the tube 112 as shown in Figures 15 and 16 releasing the  
12 swivel 124 from the distal end 116 of the tube 112. With the  
13 swivel released, the string 126 is pulled. This causes the swivel  
14 to rotate as shown in Figures 15 and 16. It will be appreciated  
15 that the curved surfaces 118c and 124e facilitate the rotation.

16  
17 When the string 126 is pulled taut, the swivel 124 will  
18 assume a position approximately perpendicular to the string 126.  
19 The pushrod 118 may then be withdrawn as shown in Figures 17 and  
20 18. Retraction of the pericardium is effected in the same way as  
21 described above with reference to the first embodiment.

22  
23 When retraction is no longer needed, the swivel 124 is  
24 removed by pulling on string 128. This returns the swivel to a

1 direction substantially collinear with the string 128 and coaxial  
2 to the axes of the incisions in the pericardium and the chest  
3 wall.

4  
5 Particular features and advantages of the second embodiment  
6 include the following. The deployment, use and removal of the  
7 swivel is very simple and effective. When both strings are  
8 pulled, the surface grooves on the pushrod prevent the axial  
9 rotation of the swivel relative to the pushrod, which could cause  
10 the strings to become entangled. The retractor only requires one  
11 entry site to deploy and remove. The end of the swivel acts as a  
12 trocar and thus obviates the need for an incising tool.

13  
14 There have been described and illustrated herein several  
15 embodiments of a pericardial retractor. While particular  
16 embodiments of the invention have been described, it is not  
17 intended that the invention be limited thereto, as it is intended  
18 that the invention be as broad in scope as the art will allow and  
19 that the specification be read likewise. Thus, while a particular  
20 proximal actuator has been disclosed, it will be appreciated that  
21 many of the advantages of the invention could be achieved without  
22 the proximal actuator or with a different proximal actuator.  
23 Also, while the tube, pushrod, and the swivel have all been  
24 illustrated and described as being substantially cylindrical, it

1 will be recognized that other cross-sectional shapes could be used  
2 with similar results obtained. Moreover, while particular  
3 configurations have been disclosed in reference to the strings  
4 passing through the tube, it will be appreciated that many of the  
5 advantages of the invention could be obtained with one or both of  
6 the strings remaining outside the tube. In addition, while the  
7 invention was designed with the intention that it be used in  
8 endoscopic heart surgery, it may be used in other types of  
9 minimally invasive surgery. It will also be appreciated that an  
10 effective retractor could be made with the central string slightly  
11 off the midpoint of the swivel. It will therefore be appreciated  
12 by those skilled in the art that yet other modifications could be  
13 made to the provided invention without deviating from its spirit  
14 and scope as so claimed.